

CHAPTER 7

AMPHIBIA

(THE FROG)

INTRODUCTION

The superclass Tetrapoda is divided into four classes of vertebrate animals with four limbs. Reptiles, birds and mammals are **amniotes**, the eggs of which are either laid or carried by the female and are surrounded by several membranes, some of which are impervious. Lacking these membranes, **amphibians** require water bodies for reproduction, although some species have developed various strategies for protecting or bypassing the vulnerable aquatic larval stage. They are not found in the sea with the exception of one or two frogs that live in brackish water in mangrove swamps. On land, amphibians are restricted to moist habitats because of the need to keep their skin damp.

The greatest event in the phylogenetic history was a transition from aquatic to terrestrial mode of life, and Amphibia were the first animals to attempt this transition. But they are not fully terrestrially adapted and hover between aquatic and land environments.

MAIN CHARACTERISTICS OF AMPHIBIANS

- 1) Aquatic or semiaquatic (freshwater), air and water breathing, carnivorous, cold-blooded, oviparous vertebrates.
- 2) Head distinct, trunk elongated. Neck and tail may be present or absent.
- 3) Limbs usually 2 pairs (tetrapod), some are limbless. Toes 4-5 (pentadactyle) or less. Paired fins are absent. Median fins, if present, without fin rays.

- 4) Skin is soft, moist and glandular. Pigment cells are (chromatophores) are present.
- 5) Exoskeleton is absent. Digits are clawless. Some with concealed dermal scales.
- 6) Endoskeleton mostly bony. Notochord does not persist. Skull with 2 occipital condyles.
- 7) Mouth is large. Upper or both jaws with small homodont teeth. Tongue often protrusible. The alimentary canal terminates into cloaca.
- 8) Respiration by lungs, skin and mouth lining. Larvae with external gills which may persist in some aquatic adults.
- 9) Heart is 3-chambered (2 auricles+1 ventricle). Sinus venosus is present. Aortic arches 1-3 pairs. Renal and hepatic portal systems well developed. The erythrocytes are large, oval and nucleated. Body temperature variable (poikilothermous).
- 10) Kidneys are mesonephric. Urinary bladder is large. Urinary ducts open into cloaca. Excretion ureotelic.

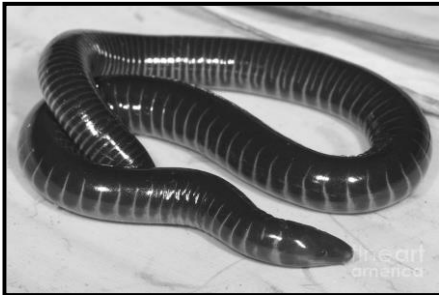
Class: Amphibia

Subclass: Stegocephalia (*Extinct*)

Subclass: Lissamphibia

O1: Gymnophiona/Apoda

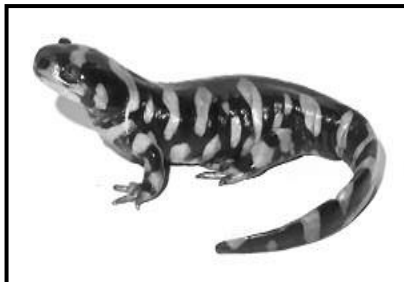
- Limbless, blind, elongated worm like, burrowing tropical forms.
- Tail short or absent, cloaca terminal,
- Skull compact, roofed with bone.
- Limb girdles absent.
- Males have protrusible copulatory organs.



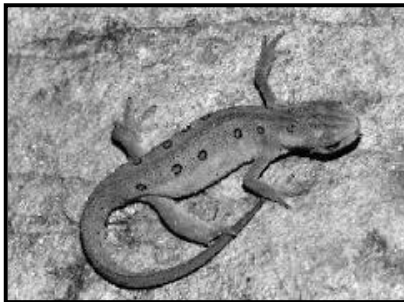
Caecilians

O2: Urodela

- Lizard-like amphibians with a distinct tail.
- Limbs 2 pairs, usually weak, almost equal.
- Skin devoid of scales and tympanum.
- Gills permanent or lost in adult.
- Males without copulatory organs.
- Larvae aquatic, adult-like, with teeth.



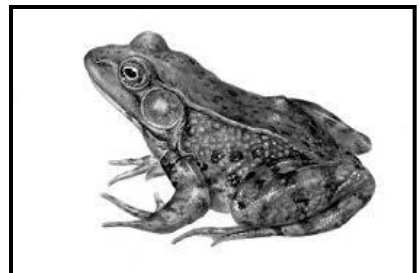
Salamander



Newt

O3: Anura

- Specialized Amphibia without tail in adults.
- Hind limbs usually adapted for leaping and swimming.
- Adults without gills or gill openings.
- Eyelids well-formed. Tympanum present.
- Skin loosely-fitting, scaleless; Mandible toothless.
- Pectoral girdle bony. Ribs absent or reduced.
- Vertebral column very small of 5-9 presacral vertebrae and a slender urostyle.
- Fertilization always external.
- Fully metamorphosed.



Frog

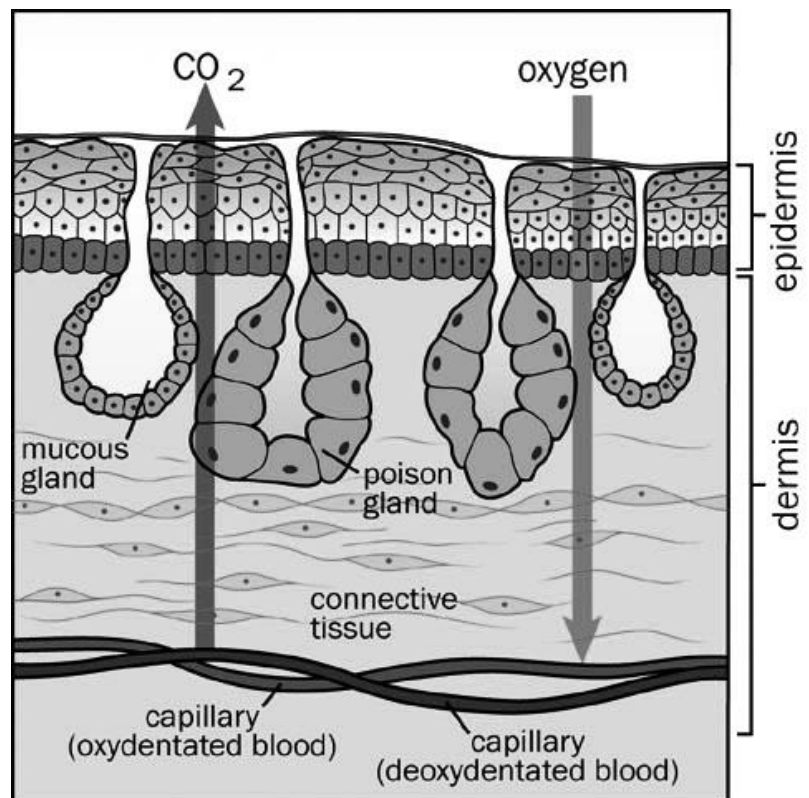
EXTERNAL FEATURES

SHAPE AND SIZE

Body of a frog is somewhat spindle-shaped, pointed anteriorly and rounded posteriorly. It is slightly flattened dorsoventrally and streamlined to swim through water. It is divisible into distinct head, trunk and limbs, there being neither a neck nor a tail. Size of adults varies from about 12 to 18 cm in length and 5 to 8 cm in width.

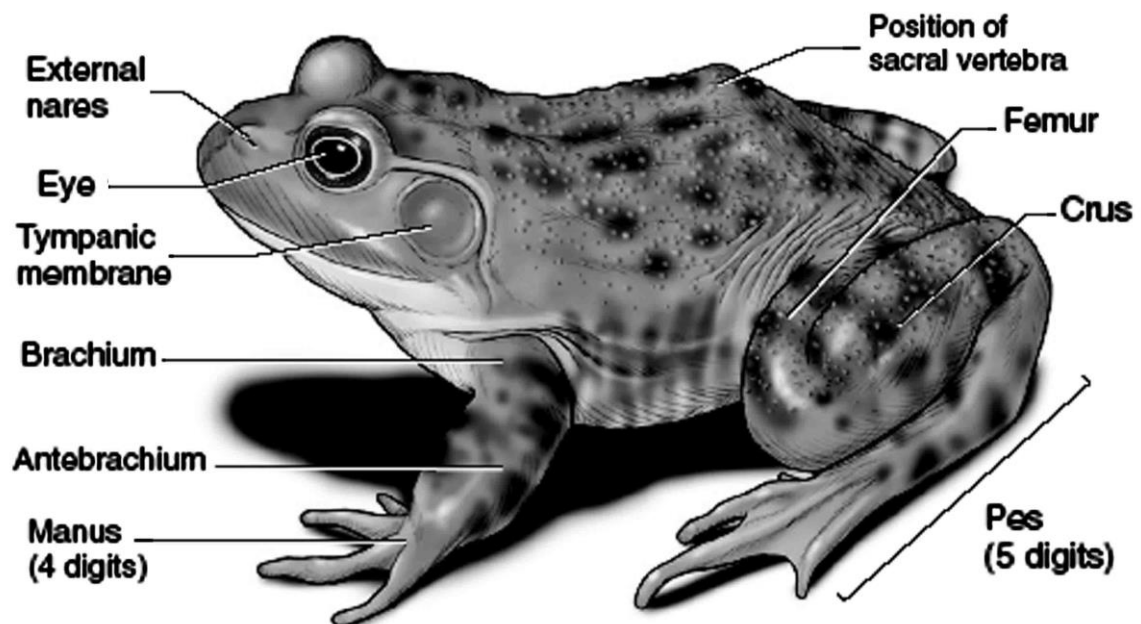
SKIN AND COLOR

Skin of frog is thin, moist, slimy, smooth and fitting loosely on the body. Skin of back has dorso-lateral folds or thickenings called *dermal plicae*. Color of skin is green with black or brown spots dorsally but lighter pale-yellow ventrally. The **color** of the skin is basically due to three layers of pigment cells. The **melanophores** lie in the deepest layers, **guanophores** lies in the intermediate layers and **lipophores** over lying these. The change in color of skin is produced by expansion of pigment in the **melanophores** under the influence of secretions of **pituitary gland**.



HEAD, TRUNK AND LIMBS

Head of frog is clearly demarcated from trunk; it is flat, roughly triangular in outline and with snout terminating in a wide transverse mouth. Two small openings, the external nares or external **nostrils**, lie dorsally above the mouth, at the tip of snout and serve in respiration. Dorsolaterally, two large, spherical and protruding **eyes** are situated on top of head. Each eye has a thick, pigmented and almost immovable upper **eyelid** and a thin semi-transparent and freely movable lower eyelid. From the lower eyelid arises a transparent third eyelid or **nictitating membrane**, which covers and protects the eye during swimming and keeps it moist in air. Behind and below each eye is a flat and deeply pigmented circular patch of skin, the ear drum or **tympanum**, that receives sound waves and there is no external ear.



The **trunk** is ovoid in shape and its back is raised in the middle in a characteristic sacral prominence of hump. At the posterior end of trunk is a small circular cloaca aperture or **vent** for the discharge of faecal and urinary wastes as well as reproductive products (ova or sperm).

The frog has two pairs of **limbs**; the short **forelimbs** arise anteriorly from trunk just behind the head. Each forelimb consists of the upper arm (brachium), forearm (antebrachium), wrist (carpus) and hand (manus) bearing 4 digits without web. During **amplexus** in breeding season, the thumb or inner finger become thicker forming **nuptial pad**. The hind limb is longer, each hind limb consists of the thigh, shank (crus), much lengthened ankle (tarsus) and large foot (pes) having 5 slender clawless toes connected by broad thin webs of skin which assist in swimming.

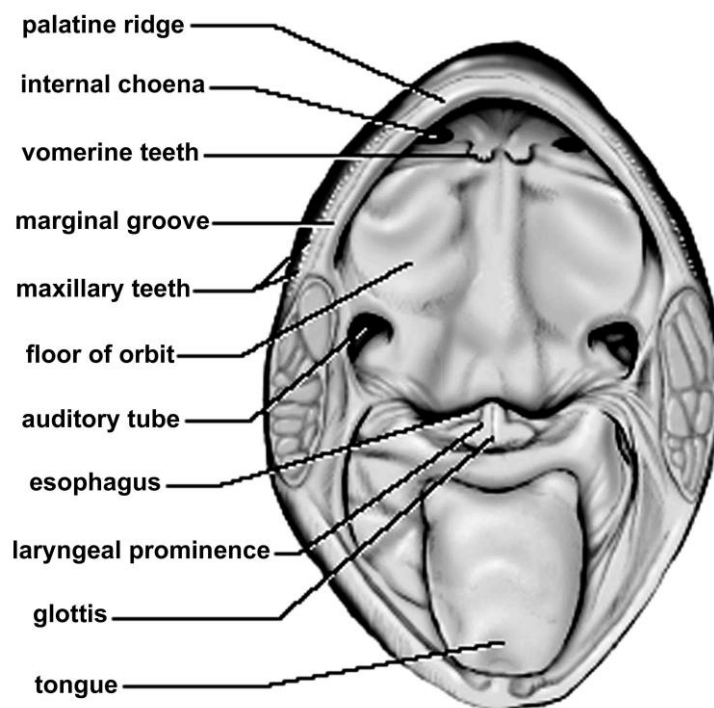
DIGESTIVE SYSTEM

MOUTH AND ORAL CAVITY

The alimentary canal begins with the **mouth** opening which is bounded by 2 bony jaws covered with immovable lips. The mouth opens in a wide **oral cavity** lined with ciliated columnar epithelia containing mucous glands for food lubrication. There is no **salivary glands**. There is a row of small conical and backwardly pointed teeth on the maxilla and premaxilla of the upper jaw, while the lower jaw lacks teeth. The vomer bones bear the **vomerine** teeth that help in holding the prey and prevent it from slipping out. Teeth are similar (**homodont**), not set in a socket (**acrodont**).

On the floor of the oral cavity lies a large, muscular sticky protrusible **tongue**. Its anterior end is attached to the inner border of lower jaw. Its posterior end is free and bifid which can be flicked out and retracted suddenly after capturing the prey with its slimy surface. There is

a pair of small opening, the **internal nares (choanae)**, by which the nasal cavities open into the oral cavity. The large posterolateral openings are the **auditory tubes**, which lead to the middle ear cavities. Ventrally in the oral cavity, posterior to the tongue, is the slit-like **glottis**, which leads to the **lungs**. The entrance into the **esophagus** is posterior to the glottis.



Oral cavity and pharynx of the frog.

RESPIRATORY SYSTEM

CUTANEOUS RESPIRATION

Cutaneous respiration goes on all the time whether frog is in or out of water. It is practically the only mode of respiration when the frog is **under water** or **hibernating**. Skin is richly supplied with blood and is permeable to gases. In addition, the skin is kept moist by the secretion of mucous from its glands.

BUCCAL RESPIRATION

The mucous epithelial lining of buccal cavity is richly supplied with blood capillaries. In the buccal respiration, the mouth remains permanently closed while the **nostrils** remain open. The floor of the buccal cavity is alternately raised and lowered, so that air is drawn into and expelled out of the buccal cavity repeatedly through the open nostrils. During buccal respiration, the **glottis** remains closed so that no air enters or leaves the lungs into the buccal cavity.

PULMONARY RESPIRATION

The respiratory tract of the frog begins with the external nostrils, nasal chambers, internal nostrils, bucco-pharyngeal cavity, glottis, laryngo-tracheal chamber and two bronchi. The frog has 2 ovoid, thin-walled and highly elastic **lungs**. They are covered externally with peritoneum. The lungs internally divided by a network of folds into small air sacs, **alveoli**.

MECHANISM OF RESPIRATION

Unlike most reptiles, birds and mammals, amphibians use a **positive pressure mechanism** to force air into their lungs. First, amphibians ventilate their lungs by first drawing air into the mouth through their nostrils (external nares). They then close their nares and raise the floor of their mouth. These actions drive air into the lung.

Inspiration

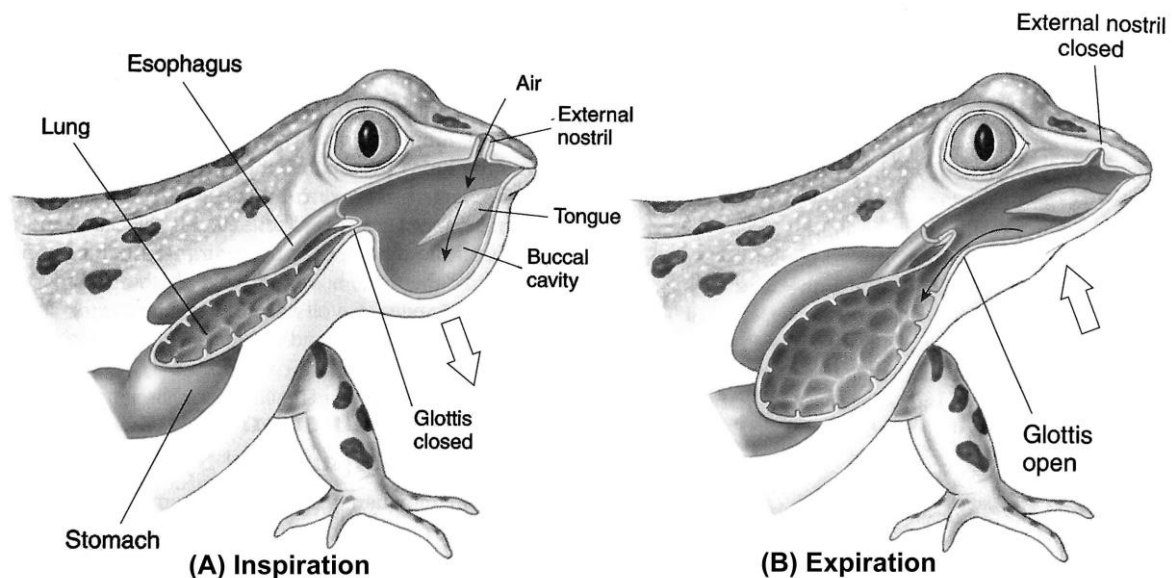
The process in which lungs are filled up with air is called inspiration. During it, glottis and mouth remains closed while nostrils remain open. The *sternohyal* muscles contract due to which the floor of buccal cavity is lowered. Thus, the buccal cavity gets enlarged and air comes into buccal cavity through nostrils. Now the glottis opens and nostrils are closed. Now *petrohial* muscles contract which raises the floor

of buccal cavity. This decreases size of buccal cavity and air passes into lungs through glottis. This completes inspiration.

Expiration

When lungs are filled with air glottis closes and air remains in lungs for some time. At this time, the floor of buccal cavity is raised and lowered to carry buccal respiration. Now glottis opens and floor of buccal cavity is lowered by the contraction of *sternohyal* muscles. This process in which lungs are emptied is called expiration.

According to recent findings, when the floor of buccal cavity is lowered fresh atmospheric air from nostrils and air of lungs from glottis come in buccal cavity and get mixed with each other. When floor of buccal cavity is raised, the mixed air of buccal cavity goes into the lungs through glottis and goes outside through nostrils. This proves inefficiency of lungs for respiration.



Schematic diagram of mechanism of respiration.

HABITS OF AMPHIBIA

Locomotion:

Frog moves in two ways, by leaping on land and by swimming in water. It's muscular and endoskeletal systems have become well specialized to do so

FEEDING:

Frogs are carnivorous animals feeding on insects, worms, molluscs caught by a sudden flip of its large protrusible sticky tongue which is attached to the front end and free behind.

Croaking:

Croaking is the characteristic noise or sound produced by frogs commonly heard in breeding season. It is produced by forcing air from lungs over vocal cords into mouth cavity and back again. Croaking is louder in males due to the presence of a pair of ballon-like loose skin fold on throat, **vocal sacs**, acting as resonators.

HIBERNATION AND AESTIVATION:

Frogs are cold-blooded animals; the body temperature fluctuates with that of the environment. During adverse environmental conditions in cold winter or dry hot summer days, frogs burry in the soft damp bottom mud for protection. They become metabolically inactive and stop feeding, living only on the glycogen and fats stored in their bodies. It depends on the cutaneous respiration only through the damp skin. This is called **hibernation** or '*winter sleep*' during winter and **aestivation** or '*summer sleep*' in summer.

Camouflage:

Frogs are not easily noticeable by their enemies as they can change the color of their skin to match with that of the surroundings. This type of protective coloration is known as **camouflage**. Changes in color are possible by dispersion or concentration of special amoeboid pigment cells in their skin.

CHAPTER 8

REPTILES

INTRODUCTION

Reptiles represent the first class of vertebrates fully adapted for life in dry places on land. They have no obvious diagnostic characteristics of their own that immediately separate them from other classes of vertebrates. The characters of reptiles are in fact a combination of characters that are found in fish and amphibians on one hand and in birds and mammals on the other. The class name refers to the mode of locomotion (*reptum*, to creep or crawl),

MAIN CHARACTERISTICS OF REPTILIA

- 1) Predominantly terrestrial, creeping or burrowing, mostly carnivorous, air-breathing, cold-blooded, oviparous and tetrapodal vertebrates.
- 2) Body bilaterally symmetrical and divisible into 4 regions—head, neck, trunk and tail.
- 3) Limbs 2 pairs, pentadactyle. Digits provided with horny claws. However, limbs absent in a few lizards and all snakes.
- 4) Exoskeleton of horny epidermal scales, shields, plates and scutes. In turtles, the body enclosed in dorsal **carapace** and ventral **plastron**, made of dermal **bony** plates.
- 5) Skin is dry, cornified and devoid of glands.
- 6) Mouth terminal. Jaws bear simple conical teeth. In turtles teeth replaced by horny beaks.
- 7) Alimentary canal terminates into a cloacal aperture.
- 8) Endoskeleton bony. Skull with one occipital condyle (**monocondylar**).
A characteristic T-shaped interclavicle is present.

- 9) Heart usually 3-chambered, 4-chambered in **crocodiles**. Sinus venosus is reduced. 2 systemic arches are present. Red blood corpuscles are oval and nucleated.
- 10) Respiration by lungs throughout life.
- 11) Kidneys are metanephric. Excretion uricotelic.
- 12) Brain with better development of cerebrum than in Amphibia. Cranial nerves 12 pairs.
- 13) Lateral line system is absent. *Jacobson's* organs present in the roof of mouth.
- 14) Sexes separate. Male usually with muscular copulatory organ.
- 15) Fertilization is internal. Mostly oviparous. Large yolky meroblastic eggs, covered with leathery shells, always laid on land. Embryonic membranes (amnion, chorion, yolk sac and allantois) appear during development. No metamorphosis. Young resemble adults.
- 16) Parental care usually absent.

CLASSIFICATION OF CLASS REPTILIA

ORDER (1) Rhynchocephalia

Lizard-like reptiles that includes **only one** living species, the **tuatara** (*Sphenodon punctatus*), which only inhabits parts of New Zealand.

- 1) Body is small, elongated and lizard-like.
- 2) Limbs pentadactyle, clawed and burrowing.
- 3) Skin covered by granular scales and mid-dorsal row of spines on its back.
- 4) Skull is diapsid. Nasal openings are separate. Parietal foramen with vestigial **pineal eye** present. Quadrate is fixed.
- 5) Vertebrae **amphicoelous** or biconcave. Numerous abdominal ribs present.

- 6) Teeth acrodont. Cloacal aperture is transverse.
- 7) Heart incompletely 4-chambered.
- 8) No copulatory organ in male.

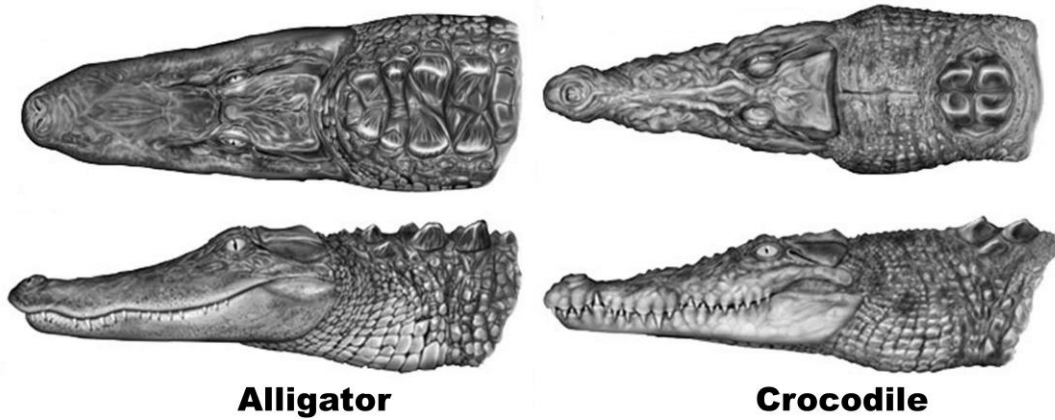
ORDER (2) Chelonia/Testudinata

- 1) Body short, broad and oval.
- 2) Limbs clawed and/or webbed, paddle-like.
- 3) Body encased in a firm shell of dorsal **carapace** and ventral **plastron**, made of dermal **bony** plates. Thoracic vertebrae and ribs usually fused to carapace.
- 4) Skull is **anapsid**, with single nasal opening. Quadrate is immovable.
- 5) No sternum is found.
- 6) Teeth absent. Jaws with horny sheaths.
- 7) Cloacal aperture have longitudinal slit.
- 8) Heart incompletely 4-chambered with a partly divided ventricle.
- 9) Copulatory organ single and simple.
- 10) About 400 species of marine turtles, freshwater terrapins and terrestrial tortoises.

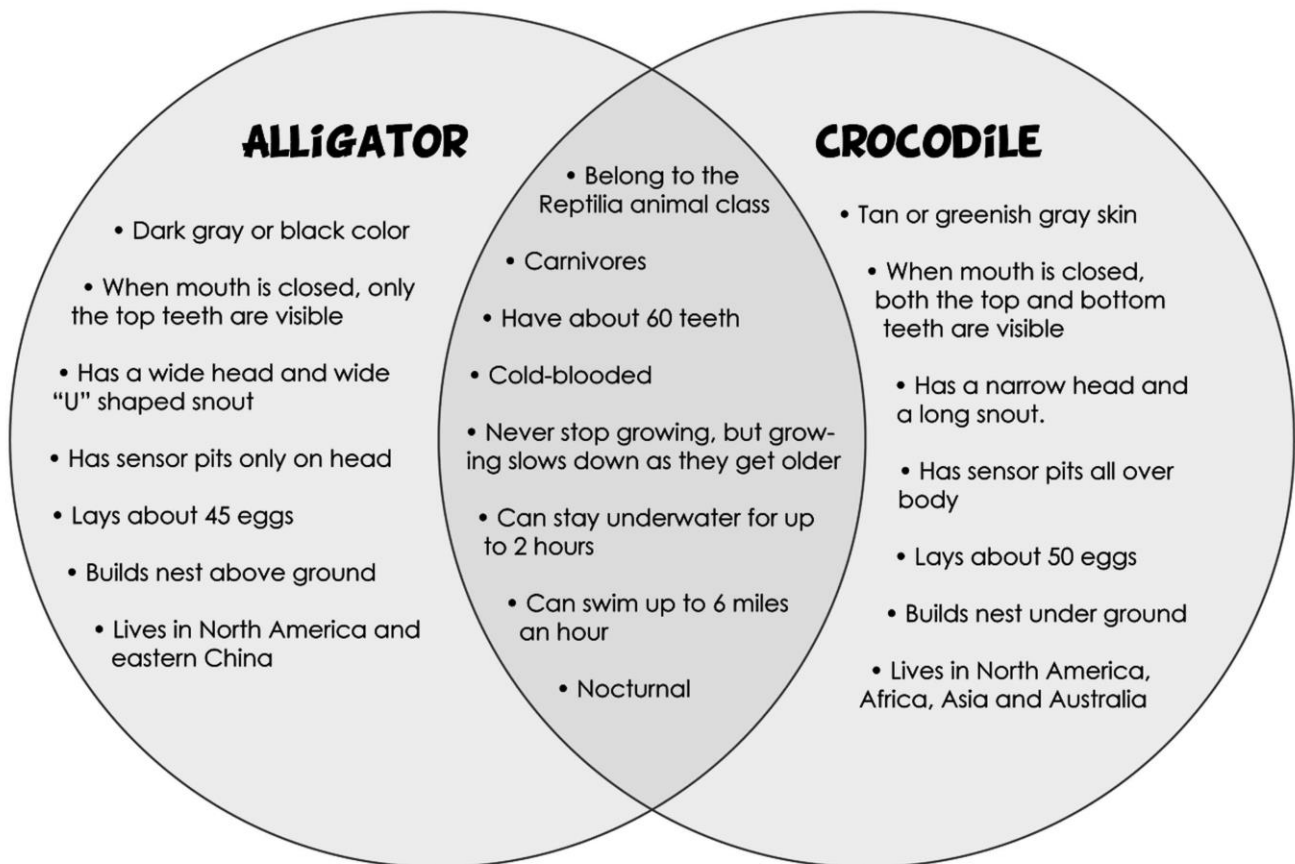
ORDER (3) Crocodilia

- 1) Large-sized, carnivorous and aquatic reptiles.
- 2) Tail is long, strong and laterally compressed.
- 3) Limbs are short but powerful, clawed and webbed.
- 4) Skin is thick with scales bony plates and scutes.
- 5) Skull is diapsid. Quadrate is immovable. No parietal foramen.
A pseudopalate present.
- 6) Ribs are bicephalous. Abdominal ribs present.
- 7) Teeth numerous, thecodont, lodged in sockets.
- 8) Heart completely 4-chambered.
- 9) Cloacal aperture is a longitudinal slit.

10) Male with a median, erectile, grooved penis.



ALLIGATORS VS CROCODILES



ORDER (4) Squamata

- 1) Advanced, small to medium, elongated.
- 2) Limbs clawed, absent in snakes and lizards.
- 3) Exoskeleton of horny epidermal scales, shields and spines.
- 4) Skull diapsid. Quadrate movable.
- 5) Vertebrae procoelous. Ribs single-headed.
- 6) Teeth acrodont or pleurodont.
- 7) Heart incompletely 4-chambered.
- 8) Cloacal aperture is transverse.
- 9) Male with eversible double copulatory organs (hemipenes).

Table (-): Differences between Snakes and Lizards.

	Suborder (1): Lacertilia or Sauria (<i>Lizards</i>)	Suborder (2): Ophidia or Serpentina (<i>Snakes</i>)
(1)	Body is elongated, lizard-like.	Body is slender, narrow, snake-like
(2)	Limbs and girdles usually well-developed	Limbs are absent, vestigial hind limbs and pelvic girdle in boa, python, etc.
(3)	Eyelids movable. Nictitating membranes present.	Eyelids fixed. Nictitating membranes absent.
(4)	Ear openings and tympanum present.	Auditory openings and tympanum lost.
(5)	Maxillae, palatines and pterygoids fixed.	These skull bones freely movable helping in biting mechanism.
(6)	Two rami of mandible firmly united anteriorly. Mouth.	Mandibular rami joined by an elastic ligament and can be non-expansible. widely separated during swallowing of large prey
(7)	Sternum, episternum and urinary bladder usually present.	These are absent.
(8)	Premaxillae bear conical teeth.	Premaxillae are toothless.
(9)	Tongue rarely notched or extensile	Tongue slender, bifid and extensile.
(10)	Both lungs equally developed.	Left lung greatly reduced.
(11)	Single occipital condyle.	Occipital condyle distinctly triple.
(12)	Cerebral hemispheres are short.	Extremely elongated and project between the eyes.
(13)	Cranial nerves 12 pairs.	Cranial nerves 10 pairs only.